LIGHT INFANTRY BATTALION-AND-BELOW BATTLE COMMAND IN THE EARLY TWENTY-FIRST CENTURY: WHAT ADVANCED C4I CAPABILITIES ARE REQUIRED AND WHICH ENABLING TECHNOLOGIES ARE NOT BEING DEVELOPED?

A MONOGRAPH
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ABSTRACT

LIGHT INFANTRY BATTALION-AND-BELOW BATTLE COMMAND IN THE EARLY TWENTY-FIRST CENTURY: WHAT ADVANCED C^4I CAPABILITIES ARE REQUIRED AND WHICH ENABLING TECHNOLOGIES ARE NOT BEING DEVELOPED? by COL Richard G. Kaiura, USA, 54 pages.

This monograph discusses light infantry battle command at battalion and below with a view focused on identifying those advanced command, control, communications, computer applications, and intelligence processing (C^4I) capabilities that will be required by the infantry force in the early twenty-first century. Current infantry technological development programs and experimentation initiatives will be examined to determine what efforts are currently underway in developing technologies which support the attainment of these capabilities. Technological shortfalls will be identified for future consideration by force developers, doctrine writers, and Army leaders to facilitate further discussion and consideration of whether such shortfalls warrant changes in current infantry technology development.

Key to determining what these capabilities are will be an understanding of what the future battlefield will be like. Examining current data to project what conflicts U.S. military forces are most likely to be employed against in the early twenty-first century, and analyzing the environments and threats U.S. military forces will most likely face in those conflicts will result in the identification of factors which must be taken into consideration when developing a list of required battle command capabilities.

A three-part construct will be employed on which to frame the battle command capabilities which will be required. This construct consists of: intelligence-surveillance-reconnaissance (ISR); C4I; and precision fires.

A review of current infantry technology developmental programs will be conducted to identify those which support the development of technologies supporting those battle command capabilities required by light forces in the early twenty-first century. A similar review will take place for those infantry technologies most recently experimented with during the Task Force XXI Advanced Warfighting Experiment.

Technology shortfalls will be identified first by matching capabilities against current programs and initiatives and then by identifying points where development efforts are lacking.

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I. Introduction.

In what was his final published paper prior to retirement in June 1995, after having served four years as the twenty-second Chief of Staff, United States Army, General Gordon R. Sullivan discussed why the Army needed to change, the dangers of waiting to change, and how to achieve the right changes in our Army.[1] General Sullivan asserted that changes in the global political landscape, in technological advances, and in the manner in which Army forces were being employed necessitated a re-evaluation of the Army's role, missions, and how it fights, both in war and in Operations Other Than War (OOTW).[2] He cautioned against resisting change to wait for a more advantageous time; citing examples in history where success went to the leader willing to press onward in the face of uncertainty.[3] Moreover, he warned that "the cost of inaction -- of waiting for a certainty never likely to arrive -- is certain failure."[4] General Sullivan went on to identify seven elements, or steps, to achieve the right changes in the Army. Included in these are the following: understanding the environment; developing a consensus for change [through doctrine]; fostering innovation and growth; and, establishing a convincing demonstration of value.[5]

The Army is moving rapidly down the path of change towards the Army of the 21st Century -- Force XXI – as laid out by General Sullivan. Not surprisingly, little debate exists over the need for change or the dangers of waiting to make changes. However, some concern does exist regarding whether the Army is pursuing the "right" changes. Much of this concern centers around the impact of technology on the design of our future Army as it pertains to the six TRADOC domains: doctrine, training, leader development, organizations, material, and soldier systems (DTLOMS). For example, General Sheehan,

CINC, U.S. Atlantic Command, reportedly expressed his concern about the use of technology as a substitute for well-trained ground troops in the military operations of the future.[6] In another example, Major General, US Army retired, Robert F. Wagner warns his readers in a recent Army Times article:

> When Force XXI becomes a reality, we are told, our soldiers will have real time knowledge of the battlefield. The dirty, dangerous and unpredictable field of battle will become a distant memory for old soldiers. The impact of this philosophy has had a devastating effect on our training: land navigation and terrain analysis are an anachronism; the mastery of tactics, techniques and procedures that facilitate warfighting are no longer relevant; synchronizing combat power as the combined arms team we must be is not necessary...Many combat skills such as mounted movement techniques, terrain analysis, and hasty occupation of a battle position remain immutable in spite of...technology. To ignore these skills is to court defeat on the battlefield.[7]

In a third example, Major General Robert Scales, Commandant of the Army War College, reportedly underscored the theme that high technology will be no panacea in the years ahead. "War is not a contest of material...war is a test of will...After the year 2010, when we begin to see the rise of a major competitor, a knowledge-based Army will not be enough. If you cannot act on what you know, you simply face the prospect of dying smarter."[8] General Scales' comments are highly cogent.

Concern regarding the future design of the Army is understandable for two reasons. First, the rapid pace of change in not only technological advancement, but also in the geopolitical environment, makes the future more difficult to visualize. The nature of the environment the Army will face in the early 21st Century is the subject of much speculation. Changes in the environments in which our forces will operate, coupled with the types of missions these forces can expect to perform, will keep pace with shifting U.S. national interests in a Post-Cold War world. Technology will continue to enable new

warfighting capabilities which, despite their greatest efforts, today's scientists will not have foreseen. Surprisingly enough, this is not new. Maurice Pearton, noted lecturer, fellow, and researcher in the field of political science, made similar observations in his study of diplomacy, war and technology during the period 1830 to 1945.

> So military and political planners have to work to situations envisaged up to two decades in advance. They are, therefore, driven to base their policies on assumptions about the configuration of states...during that time. In [the past], Napoleon III and Moltke could plan with confidence that the uncertain factors were confined within reasonably firm limits...By the middle of the twentieth century, the policy deductions of governments have no such limits. For them, it is no longer a question of conjecturing what is going on '[on] the other side of the hill' -- it is a problem of postulating which hill up to twenty years in advance, years during which rapid changes in science and technology are likely...uncertainty characterizes...policy making and it takes two forms: technological uncertainty stemming from the need to investigate pure theory; and political uncertainty stemming from the course and character of world politics over a twenty year period.[9]

Second, the consequences of not "getting it right" can lead to failure in war and, subsequently, a failure to protect vital U.S. interests. There is probably no more fitting an illustration of this point than the tragic defeat suffered by France in 1940 at the hands of the German army. Colonel Robert Doughty, in his book, *The Seeds of Disaster*, documents the actions of French leaders, both military and civilian, in attempting to glean lessons from their success during World War I and apply them to their preparations for the next war. Doughty's assessment of where they went wrong is instructive.

> When the battle was fought, the failure to anticipate the rapid movement of large forces so quickly through Luxembourg and the Ardennes was rooted in the incorrect perception of that area as an obstacle and a misunderstanding of the mobility available from the new weaponry...the mistake was creating an army that could not reply to the unexpected or respond to the limited threat. Where flexibility was needed, France and her military were content with an inflexible concept of war and a rigid, step-by-step doctrine.[10]

Doughty's final conclusion is a clear and stinging indictment of France's failure to "get it right" – an indictment of which no nation wants to be guilty.

> [France's] failure was not one of stupidity, decadence, disloyalty, or defeatism; it was one of having decided upon the wrong solution.[11]

Currently, America's Army is engaged in an examination of one of the central topics which occupied France more than seventy years earlier; defining the institutional philosophy of command that will shape its organization and doctrine in future years. In today's terms, this topic is referred to as "battle command." "Battle command" is defined as the art of decision-making, leading, and motivating informed soldiers and organizations into action to accomplish missions at the least cost to soldiers.[12] Just as it was for France in the inter-war years between 1919 and 1940, so it is with America today that changes to our Army in the early twenty-first century must be the "right" changes. France's decision to adopt a centralized, rigid and set-piece approach to command doomed it to failure in the face of an aggressive, highly mobile enemy. As America's Army moves into the Twenty-first Century, the decisions its leaders make regarding battle command will play a major role in determining whether it succeeds or fails. As its definition indicates, battle command involves decision-making, leading and motivating informed soldiers and organizations; all cognitive skills contained within leaders. Such skills, however, are dependent on the circumstances in which they must operate; the fog and friction of war. They are also, to a certain degree, enabled by the processes and technologies which support them. Commanders currently train to fight in an environment of uncertainty, where knowledge of the enemy's actions and intentions are imperfect at best, employing Army of Excellence doctrine and force structures. Current efforts to achieve a better, even optimal, picture of what is taking place on the battlefield promise to remove this

shroud of uncertainty. The resultant effect will change the manner in which we "lead" and the way we structure our forces. Robert Leonhard commented on this very point when he stated:

> When technology hands us a clear picture of battlefield truth, it strikes at the heart of our doctrine, organization, and tactical concepts. Our battlefield formations, planning procedures, and tempo are founded upon ignorance of the battlefield, which heretofore has been fundamental to warfare. If we get to the point at which leaders can reliably, accurately, and instantly see the truth on the battlefield, our methods and practices must radically change.[13]

Successful battle command in the early twenty-first century will rely heavily on and be enabled by advanced command, control, communications, computer applications, and intelligence processing, or "advanced C^4I". Advanced C^4I is the first of two sub-topics which frame the research supporting this monograph. Advanced C^4I encompasses those technologies by which commanders and their staffs: translate the awareness of what is occurring on the ground in a broad geographical arena into an understanding of what is taking place there; and, communicate that understanding quickly, surely, and accurately in a useable form to combat forces.[14] It also encompasses those technologies used by commanders and their staffs to analyze situations; develop, wargame courses of action; produce orders; and conduct rehearsals. Since this topic applies broadly to the Army as a whole, this author chose a second sub-topic within which to frame this monograph -- the light infantry force[15] -- for reasons which will now be explained.

Much effort has been expended towards developing and testing advanced C^4I technologies for mechanized infantry forces. The unique characteristics of light infantry forces have placed weight and bulk challenges on these technologies that few in industry have apparently been willing to address. Due in part to this, the vision of the future as it

pertains to light infantry advanced C^4I is less developed than other parts of our Army. James Dunnigan, author of *Digital Soldiers*, in evaluating this vision, writes, "The future of the digital infantry is a complicated and murky one."[16] Dunnigan, who appears highly skeptical of technology, particularly where it concerns the infantry soldier, makes his assessment based on an awareness that there are numerous problems and high costs associated with these technologies which still must be overcome.[17]

This fixation on the development of heavy force technologies was also noted in a monograph written by Major Brian D. Jones, *Force XXI: What are the Risks of Building a High Tech, Narrowly Focused Army.* Major Jones concludes in his monograph that there is an "apparent intellectual and acquisition fixation of the U.S. Army in developing a future force that is expressly designed to dominate the mid- to high-intensity fight, while marginalizing the risks associated with a low intensity opponent."[18] He argues that "future light forces must be every bit as capable as the currently envisioned future heavy force in defeating WMD [weapons of mass destruction] and other technologically enhanced threats."[19]

One might be tempted to ask whether the technologies being developed for heavy forces might not be employed just as well by light forces. After all, both forces are infantry-based. The answer is a qualified "no." Certain technologies can and do benefit both, such as those systems being developed for the Army Battle Command System. However, the bulk and weight considerations previously mentioned make many technologies developed for the heavy force impractical for use by light infantry forces. In addition, light infantry forces will require technologies providing far greater resolution in three dimensional environments heavy forces cannot operate.

This monograph focuses on an assessment of Army light infantry military operations, battalion-level and below, the identification of the environments in which these operations will most likely be performed in the early 21st Century, and the subsequent development of implications regarding Force XXI light infantry force advanced C^4I technologies. The research methodology used in the preparation of this monograph is based primarily on literature review and personal observation.

The thesis of this monograph is that the Army is currently not addressing several key technological areas critical to the optimization of battle command in light infantry forces in the early twenty-first century.

The primary research question is: <u>What advanced C^4I technologies for the light infantry force, not yet under development, are required in order to enable or enhance light infantry battalion and below battle command in the early 21st Century</u>? To determine the answer to this question, three supporting research questions are answered. First, this monograph answers: <u>What is the current vision of future war and conflict in the early twenty-first Century</u>? The nature of future war and conflict as envisioned by the Army and other authors on this topic are examined with a focus on the environments and threats light infantry forces will most likely be employed in and against. In many instances, these areas will create the challenges technology will need to overcome in the early twenty-first century. Second, this monograph answers: <u>What advanced C^4I capabilities will light infantry forces require in the military operations environments of the early twenty-first century</u>? The challenges posed by future environments and threats will be examined to identify future capabilities needed in the area of battle command and advanced C^4I. Views of selected writers on future technology requirements will also be incorporated into this

examination. Third, this monograph answers: What light infantry force battle command technologies are currently being developed and what shortfalls in research exist? Technologies currently under development will be identified and examined to determine any shortfalls between current programs and future capability requirements. Implications and recommendations regarding current and future technology developments will be offered.

The intended audience for this monograph includes force developers, doctrine writers, light infantry unit commanders, TRADOC Battle Labs and Army leaders responsible for the future development of light infantry force technologies.

II. Vision of Future War and Conflict in the Early 21st Century.

The development of technology for the light infantry force in the early 21st Century depends a great deal on how future warfare is envisioned; particularly with regard to the types of conflict, threats, and environments most likely to be encountered by light infantry forces. Preparation for military operations on the battlefields of the future must first start with an understanding of what those conflicts, threats, and environments are likely to be. In this section, all three will be addressed.

During his presentation at the Ninth Annual Strategy Conference, held at Carlisle, Pennsylvania in early 1998, John F. Guilmartin recounted, in jest, an anonymous point of view regarding how the environment and technology of future military operations relate.

> Some years ago an American military pundit...came up with an astonishingly effective law for predicting the location of our next military commitment...Closely examine our military footgear, then identify the country and climate for which it is least well suited, and that's where we're headed.[20]

Guilmartin's military pundit notwithstanding, we know from experience that factors such as terrain and weather significantly affect the efficiency of technology employed by light infantry forces. Though Guilmartin's primary focus was on the effectiveness of asymmetrical technologies as demonstrated in several historic settings, he reached several conclusions regarding the impact of environment on technology. First, Guilmartin maintains technological effectiveness is mediated by such basic factors as geography, topography, climate, and culture.[21] Secondly, he notes that what works against one enemy might not work against another for reasons unrelated to the technology being employed.[22] A clear understanding of the future environments in which light infantry forces will likely operate is vital to the technology selection and development process.

The U.S. Army's conceptual foundation for the conduct of future operations in both war and operations other than war (OOTW) is contained in Training and Doctrine Command (TRADOC) Pamphlet 525-5.[23] This pamphlet, developed when General Frederick M. Franks was Commanding General, TRADOC, defines TRADOC's vision of future military operations in the early decades of the 21st Century. As such, it provides the foundation upon which operational concepts for the future Army - Force XXI Operations - are now being developed.[24] Soldiers and leaders will continue to be the center of focus as doctrine, training, leader development, organizations, material and soldier domains are redefined and changed by the impact of technological change.[25]

According to the authors of TRADOC Pamphlet 525-5, the strategic environment is changing, being restructured by numerous forces in the world today. This complex array of forces includes: (1) the shift of unstable regional balances of power; (2) the replacement of communism ideology by nationalism leading to inter-/intra-state conflicts; (3) the rejection of Western politics and values by non-Western nations; (4) the competition between state and non-state rivals; (5) the creation of massive refugee migration brought on by population growth and regional natural disasters; (6) the collapse of governments and failed nation-states; (7) the disruptive effects of technological acceleration on the way businesses operate changing the flows of commerce and wealth; (8) the increase of environmental pollution and extant tensions between violator and victim nations; and (9) the advances of information technology.[26] Environment and threat combinations associated with a traditional pre-Cold War world are being reshaped by these forces.

The pace and length of deployment of our military forces, particularly our light infantry forces, has dramatically increased. From 1950 to 1989, our Nation required 10 major Army deployments. Since 1990, there have been a total of 27 major Army deployments -- a 16-fold increase in the average number of deployments per year. Moreover, soldiers are remaining deployed longer than ever before.[27] Figure 1 below depicts the number and types of deployments experienced by U.S. Army forces between 1990 and April of 1996. More significant than the number, however, are the types of

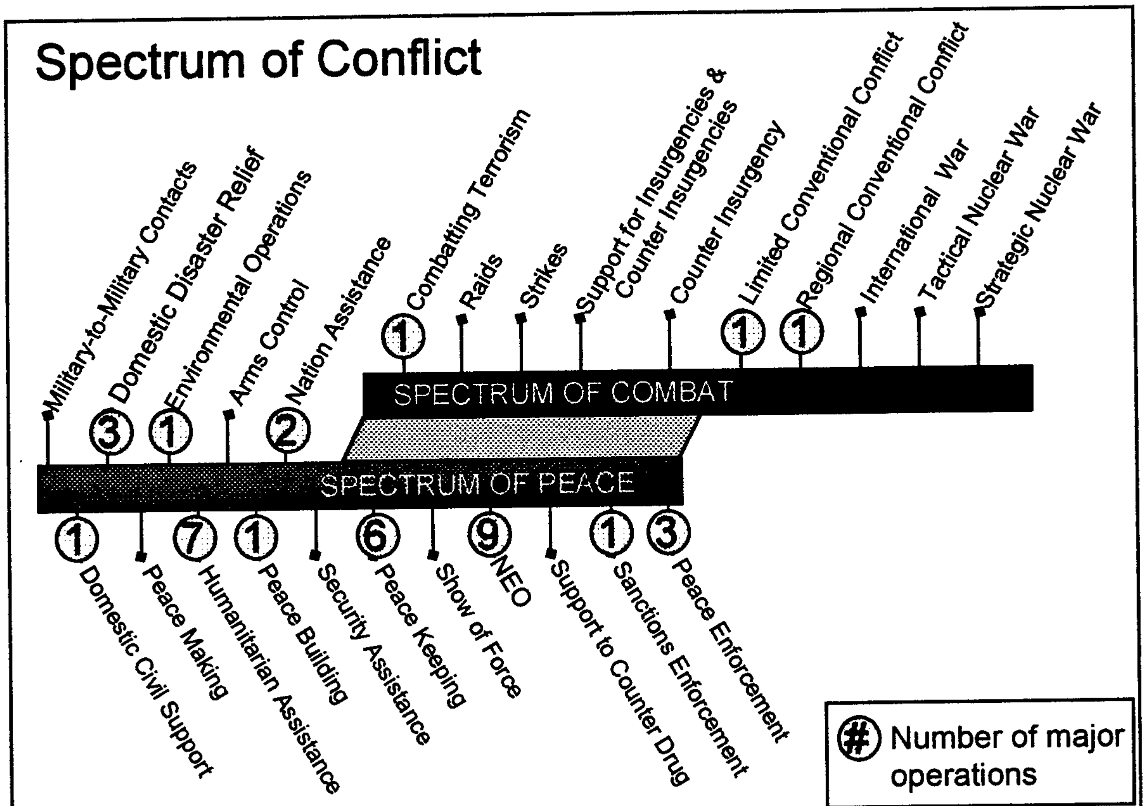


Figure 1. Spectrum of Conflict (Number of major operations US Army forces supported during the period 1990 to 1996.[28]

missions in which U.S. Army forces are being employed. By far, the preponderance of missions (95%) being performed are focused on the lower end of the conflict spectrum; what our doctrine used to call "low intensity conflict."[29] In addition, the focus of Post-Cold War deployments has shifted from Central Europe and a NATO-centric focus to

locations such as Africa (Somolia, Rwanda, Sierra Leone, Liberia), Southeastern Europe (Croatia, Macedonia, Bosnia), the Middle East (Saudi Arabia, Kuwait, Iraq, Sinai Peninsula), and Southeast Asia (Philippines, Bangladesh).[30]

So what about the future? Between now and the early 21st Century, TRADOC envisions that the pattern of conflict involvement, which the U.S. has demonstrated in the Post-Cold War world, will continue as the U.S. shapes the strategic environment in pursuit of its core objectives -- to enhance U.S. security, bolster America's economic prosperity, and promote democracy abroad.[31] TRADOC Pamphlet declares, "The types of crises and conflicts we have experienced since the end of the Cold War will likely continue into the early decades of the twenty-first century."[32] According to Steven Metz, a noted professor and scholar in the fields of military science and strategic studies, this view is widely shared within the Department of Defense. Metz observes, "The orthodox position within the Army and the Department of Defense holds that the strategic environment of 2020 will be much like that of 1997."[33] While TRADOC acknowledges that the U.S. must still be prepared to fight open wars against advanced, armor- and mechanized-based armies, this is not where the most effort and time will be spent in the next ten to twenty years. TRADOC makes a distinction, one which may be a harbinger of significant change. "Most of the conflicts involving the U.S. Army will be OOTW or low-intensity conflicts, as few states will risk open war with the U.S."[34] As previously noted and discussed, this prediction of military operations focused on OOTW appears to be supported by the last eight years of activity in which U.S. forces have been engaged.

The second aspect of future war that has and will continue to change centers on the threats our military forces will face. When the Union of Soviet Socialist Republics

(U.S.S.R.) folded at the end of 1991, the monolithic "threat" collapsed.[35] In the brief time period from the fall of the Berlin Wall to the fall of the U.S.S.R., there was an expectation that peace would follow. The absence of significant threats to peace was implicit. Samuel P. Huntington made this point when he noted the following.

> The expectation of harmony was widely shared. Political and intellectual leaders elaborated similar views. The Berlin Wall had come down, communist regimes had collapsed, the United Nations was to assume a new importance, the former Cold War rivals would engage in partnership and a grand bargain, peacekeeping and peacemaking would be the order of the day. The President of the world's leading country proclaimed the new world order; the president of, arguably, the world's leading university vetoed appointment of a professor of security studies because the need had disappeared.[36]

The view of a Post-Cold War world in harmony was short lived. While the "monolithic threat" and its concomitant Cold War threat paradigm no longer existed, many smaller, more diverse threats emerged justifying concern on the part of the United States. Responding to the inadequacy of the Cold War threat paradigm, TRADOC adopted a new model in which to portray the various threats to U.S. military forces

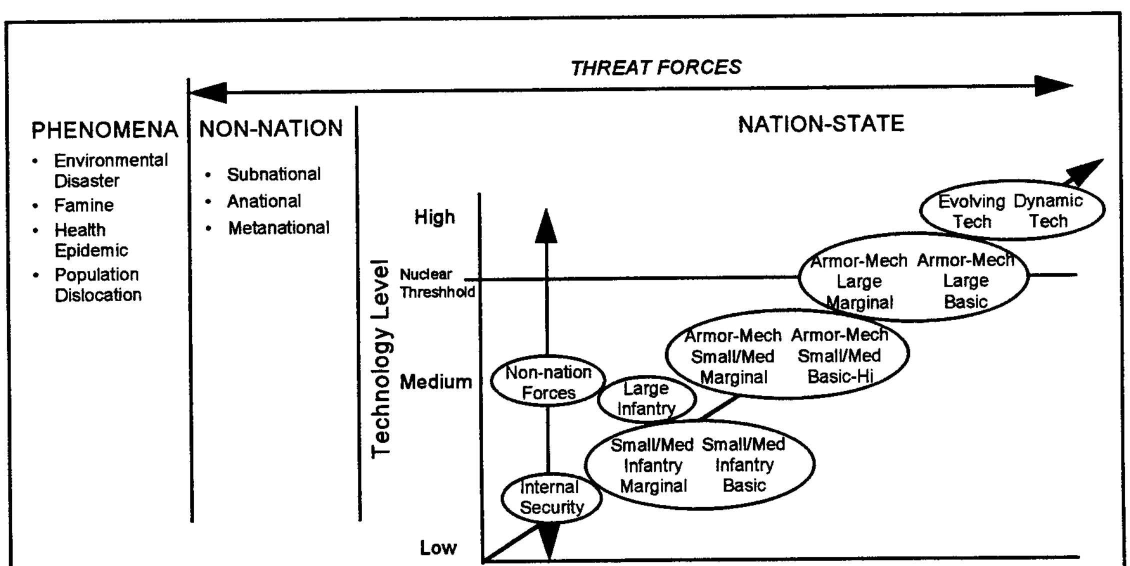


Figure 2. TRADOC Threat Spectrum Model.

extant. Figure 2 shows an array of threats which currently confront our military forces across a broad range of military operations. TRADOC divides these threats into three distinct categories: phenomena, non-nation, and nation-state.[37]

Phenomenological threats include those non-military threats which result from natural or man-made disasters, famine, epidemics, and population dislocations.[38] Responses to these threats would most likely involve non-governmental agencies (NGOs), private voluntary organizations (PVOs) and other government agencies (OGAs) in a coordinated effort to provide humanitarian assistance and disaster relief.[39] Military forces might provide early response by delivering essential supplies and services until other agencies could respond. Thereafter, military forces might be required to secure and facilitate NGO/PVO/OGA efforts. Light infantry forces have been involved in many such military operations since the end of the Cold War.

Non-nation threats encompass those groups, entities, movements or organizations not officially linked to any nation-state, but whose existence and actions clearly pose a threat to nation-states. These threats are further divided into three sub-categories: subnational, anational, and metanational.[40] Subnational threats include political, racial, religious, cultural and ethnic groups that challenge the authority of a nation-state from within. An example of such a group is the Islamic Fundamentalist Sect, associated with Ayatollah Khomeni, which brought down the Government of Iran. Anational threats are those entities which have no desire to operate under the authority of their nation-states. These entities include organized regional crime syndicates, pirates, and terrorist organizations. Examples include the warlord factions operating in Somalia, Indonesian pirates operating in the Straits of Malacca, and terrorist organizations such as Hamas and Sinn Fein.[41]

Metanational threats are those movements and organizations that operate beyond the limits of the nation-state on an interregional or global scale. Examples include religious movements, international criminal organizations, and informal economic organizations that facilitate weapons proliferation.[42] American light infantry forces may be employed directly against some of these non-nation threats in the future. But, if not, these threats will nonetheless affect the ability of light infantry forces to accomplish their missions. Somali war lords and their paramilitary clans operated with debilitating impact on multinational force operations in Somalia and ultimately set back United Nations relief efforts in this famine plagued nation.[43]

Nation-state threats span a broad range of the TRADOC threat spectrum from internal security forces to large armor-mechanized forces. Internal security forces are those small, poorly trained and equipped forces in less developed nations that can maintain order within a nation but would be severely challenged in having to defend its borders or conduct protracted military operations.[44] Examples of these forces include Honduras and El Salvador military forces. Infantry-based armies comprise the bulk of the less developed world's armies. Resembling the armies of World War I, these forces are dependent on dismounted infantry for the bulk of their combat power.[45] Examples of these forces include Afghanistan mujahadeen and the armies found in many African nation-states. Armor-Mechanized based armies, on the other hand, comprise the bulk of the industrialized world's military forces. These forces employ armored vehicle weapon systems in a large portion of their units. Their organizations are hierarchical for the most part and capable of operating in large military formations.[46] All developed nations and some less developed nations have armor-mechanized based armies. Light infantry forces

are generally employed against armor-mechanized based armies only in constrained terrain and urban environments where armored vehicles are unable to maneuver in massed formations and are highly vulnerable to dismounted infantry tactics and weaponry.

From the above discussion, it is clear the TRADOC threat spectrum model, supported by a number of noted authors, expands the range of future threats facing U.S. military forces. Ralph Peters, a retired military officer, in his article, "*Our Soldiers, Their Cities,*" confirms the diversity of the TRADOC threat spectrum when he writes concerning the future of warfare, "...there are multiple players beyond the purely military, from criminal gangs to the media, vigilante and paramilitary factions within militaries, and factions within those factions."[47] Robert Kaplan, noted world traveler and author of the travel log, "*The Coming Anarchy,*" paints a stark picture of the threat reflecting not only the diversity already noted, but also the threat posed by the social environment as well.

> [West Africa is] the symbol of...demographic, environmental, and societal stress, in which criminal anarchy emerges as the real "strategic" danger. Disease, overpopulation, unprovoked crime, scarcity of resources, refugee migrations, the increasing erosion of nation-states and international borders, and the empowerment of private armies, security firms, and international drug cartels...[48]

Robert J. Bunker, noted scholar and researcher, whose focus is on the influence of technology on warfare and political organization and on the national security implications of emerging forms of warfare quotes Xavier Raufer in responding to the question, "What is the threat?" Raufer, a national security expert, characterizes future threats as "new half-political, half-criminal powers". Bunker adds that these entities will flourish in the future as the number of failed-states increases. These entities, Bunker argues, will disregard Western-based "laws of war" and "rules of engagement"; nor will they be concerned about

concepts such as "legitimacy" or "public opinion."[49] It appears that future threats to U.S. military forces can not be expected to play by any quixotic notion of "right and wrong." Charles Dunlap maintains that future conflicts involving the US will likely be against opponents whose morals, values, political and cultural norms differ from ours. Our opponents will most likely come from societies that see the emergence of a new "warrior" class, brought up to fight and kill without pity.[50] These societies, Dunlap maintains, will seek out and exploit US values as weaknesses in a nation with an intense aversion to war.[51] The TRADOC threat spectrum, then, engenders a broad array of future opponents to be faced by U.S. light infantry forces. But against what backdrop are these forces to be engaged?

The third aspect of future war that is changing involves the environment in which future conflicts will occur. In this, there appears to be a widely supported view point -- the future battlefields and operational environments of the early 21st Century will be urban ones. One author, Russell Glenn, an analyst employed by RAND, believes that American participation in future urban operations is inevitable. He writes, "More frequently than in the past, future missions will absolutely require military operations in cities and their environs."[52] Glenn maintains the military operations in urban terrain, or MOUT, will involve both regular and special operations forces, not just elite forces. He cites Operation Just Cause in Panama and relief efforts in Mogadishu, Somalia as examples supporting his point. According to Glenn, reserve and national guard forces also will be engaged in supporting MOUT in the future. Glenn emphasizes that future MOUT will be focused on the broad range of military operations spanning the conflict spectrum, both at home and abroad.[53] Disaster relief operations associated with Hurricane Andrew and

support to civil authorities during the Los Angeles Riots are just two instances where National Guard forces played a significant role during MOUT operations in an urban environment.

Ralph Peters agrees with Glenn's prediction of the future environment of US military force operations. "The future of warfare lies in the streets, sewers, high-rise buildings, industrial parks, and the sprawl of houses, shacks, and shelters that form the broken cities of our world...Cities have always been centers of gravity...they concentrate people and power, communications and control, knowledge and capability...they are the post-modern equivalent of jungles and mountains."[54] Peters argues that we will not be able to avoid operating in urban settings, whether it be deployments short of war or full-scale city combat.[55]

One of the main reasons for this future shift to urban environments is related to the increasing urbanization of the populations of the world. The shifting of military operations to urban environments will occur because this is where the conflicts will be centered. In an excellent study of urban trends in developing world nations, Matt Van Konynenburg discusses this view point. His study, written to educate warfighters on the complexities and issues of developing cities, describes cities as becoming overwhelmed by increasing flows of citizens and rural refugees. The increased population size of these cities places a tremendous burden on what he terms "inadequate infrastructures"; cities simply lack the resources and infrastructure to cope with rising population numbers. The result is the creation of instability, both in cities and ultimately in nations.[56]

Van Konynenburg indicates that by the year 2015, 24 of the world's 30 largest cities will be in developing nations. Moreover, by 2020, the developing nations will account for

over 90 percent of the world's population growth since 1930.[57] Urbanization, especially on this magnitude, will only increase tensions in the population; conflict will be inevitable. Violence, according to Van Konynenburg, is becoming more common in these urban environments. In some cases, it directly threatens the security of the nation in which these cities are located. Van Konynenburg posits that in such cases, "international military forces may be requested to intervene. When called...[these] forces must be ready to identify and cope with the unique problems of the urban theater."[58]

Another reason for this shift in military operations hinges on the fact that the U.S. military's future opponents will have a "vote." In the 1998 Strategic Assessment, published annually by the Institute for National Strategic Studies, the authors declare, "The enemies of the United States are...few, isolated, and relatively weak. No global challenger or hostile alliance is on the horizon."[59] Because of this, no nation-state today would look to challenge the U.S. military in battle on open terrain. However, this does not mean that the U.S. can not be challenged militarily. One need only look to recent history in Mogadishu, Somalia, to see how, in the shadow of Operation Desert Storm, it was possible for a weak military opponent to thwart U.S. military forces and force them from the battlefield.[60]

The United States boasts the world's premier military force. However, it possesses vulnerabilities that can be exploited in certain environments by a determined and unscrupulous enemy capitalizing on "asymmetry" between U.S. and opponent forces.

"Asymmetry" has emerged as a relatively recent buzzword for a concept that has existed since wars were first fought. One clear definition and discussion of "asymmetry" is

offered by Lloyd J. Matthews, noted author and editor of Parameters, the U.S. Army War College Quarterly.

> In formal terms, we define asymmetry as any militarily significant disparity between contending parties with respect to the elements of military power broadly construed. Asymmetrics invites study of the fact that elements of military power are never applied in a vacuum, but always in particular political, economic, cultural, religious, psychological, geographic, and climatic contexts that qualify the utility of each element of power and condition the way each acts against the other elements of power.[61]

Many of the U.S. military's future opponents have already recognized the "asymmetric" advantages offered by urban environments. Van Konynenburg maintains, as a result of this realization, the shift of guerrilla insurgencies into cities is inevitable. He gives several examples such as Monrovia, Liberia and Kabul, Afghanistan. Guerrillas are adapting their insurgent strategies to urban environments with greatly enhanced results. Van Konynenburg argues that urban warfare favors the unconventional force and the use of media.[62]

As effective as guerrilla insurgency might be, criminal organizations are even more so. Criminal organizations are better resourced having both longevity in structure and connections to financial resources not available to rebel insurgents. Van Konynenburg concludes in his study that because of this, criminal organizations are more able to affect local government officials and intimidate government institutions.[63] The implications for military operations are stark. Van Konynenburg contends that an outlaw organization need not be great to present a threat to stability. Such an organization could affect military operations by controlling a single slum area. As a result, "such power will have to be negotiated with or neutralized by any intervening force. If not, an occupying force may find itself fighting two forces; the installed government and the insurgents."[64]

In the early 21st Century, technology will not have eliminated the requirement for light infantry forces to conduct military operations in urban terrain. Marine Corps General Jack Sheehan, Commander-in-Chief, U.S. Atlantic Command, is a subscriber to forecasts contending that the world's population is shifting toward coastal, urbanized areas. More significantly, General Sheehan views coastal, urban areas as locations where "boots on the ground", a reference to soldiers, have more value than high-technology aircraft. Sheehan states, "Combat in an urban area does not require airplanes. Combat in an urban area...requires tough infantrymen."[65] While infantrymen would clearly not compose the entire military force employed in the urban environments of the future, their presence is assured in any situation where combat is even remotely possible.

In summary, future war and conflict in the early 21st Century will be one of continued engagement in military operations spanning the conflict spectrum, but focused predominantly on the lower end of that spectrum towards military operations other than war (MOOTW). While our forces, particularly light infantry, must remain prepared to conduct combat operations in support of major and lesser theater wars, the preponderance of their time and effort will focus on MOOTW. They will face an increasingly diverse array of opponents who, seeking to avoid traditional U.S. military strengths in direct combat on open terrain, will favor asymmetric warfare and operations in complex terrain using the advantages afforded by operating in urban environments. They will do so in countries which are likely to be far from our shores under conditions where disease, absence of sanitation, famine, overpopulation, refugee migration, and the absence of strong, legitimate government are all likely to exist. There will most likely be several competing factions present which will be driven by self-interest and capable of committing

atrocities against each other. In such environments, it will be difficult, if not impossible, to tell friend from enemy. Circumstances will be capable of changing rapidly. A premium will be placed on maintaining situational understanding of the population, its controlling factions, and the military operations of our own forces.

Environmental factors likely to challenge advanced C^4I technologies in such environments include: the compartmentalization effects of operating in street and building environments; limited fields of vision; short line-of-sight distances; the degrading effects on communications created by operating in urban terrain; and the increased complexity such an environment poses in terms of visualizing and understanding what is taking place. Threat factors likely to challenge these same technologies include: the increased difficulty in identifying and tracking an enemy that can literally blend in against the masses of non-combatants; the inability to rely on traditional line-of-sight methods to warn of an enemy's approach until it has closed within close-combat ranges; the increased difficulty in determining the enemy's intentions; and the increased complexity of formulating schemes of maneuver in a three-dimensional environment against an uncooperative enemy whose doctrine may be little known or understood. The future presents us with a formidable challenge, indeed.

III. Light Infantry Advanced C^4I Capabilities in the Early 21st Century.

Soldiers will continue to form the core of our Army's warfighting and peacekeeping forces in the early 21st Century. Technological advances have made simple missions such as long range precision strikes and surveillance possible without human presence on the battlefield. Technology notwithstanding, war and MOOTW will continue to be conducted in environments too complex for technological solutions to be even remotely effective; soldiers will be the key to success in future military operations for a long time to come. This is indisputable, especially in the urban environments in which we expect to conduct future military operations. Commenting on this point, Ralph Peters states,

> [While] we seek to build machines to enable us to win while protecting or distancing the human operator from the effects of combat...urban combat remains extremely manpower intensive.... machines probably will not dominate urban combat in our lifetimes and the soldier will remain the supreme weapon.[66]

Infantry units in general, and light infantry units in particular, are called upon to play a predominant role in missions whenever soldiers may be required to stand in harm's way. This is in keeping with the Infantry's enduring mission - To close with the enemy by means of fire and maneuver to defeat or capture him, or repel his assault by fire, close combat, and counterattack.

The question now pursued is how to enhance the battle command capabilities of light infantry forces operating in the environments and against the threats expected in the early twenty-first century. In short, what advanced C^4I capabilities are envisioned as being required? Before answering this question, it will be useful to lay out a simple construct that identifies those domains within which this monograph will endeavor to describe the advanced C^4I capabilities required by light infantry units, battalion and below, in the early

twenty-first century. Earlier, MG Scales was quoted as having stated, "If you cannot act on what you know, you simply face the prospect of dying smarter."[67] His point is supported by John Arquilla, noted professor and consultant, who contends that the historical record, both ancient and modern, reflect a mixed review of the importance of information dominance in achieving success in battle. According to Arquilla, "...while knowing more has often provided the necessary conditions for achieving startling victories, information dominance alone has rarely generated sufficient conditions for winning."[68] Information is not enough. Commanders and their staffs must be able to take what they see, understand it, develop appropriate courses of action for consideration, decide on a course of action, and send the decision and related instructions to a force capable of implementing that course of action.

In their book titled "Dominant Battlespace Knowledge: The Winning Edge," Johnson and Libicki identify three categories of technological requirements emerging from the current revolution in military affairs (RMA): intelligence, surveillance and reconnaissance (ISR); command, control, communications, computer applications, and intelligence processing (C^4I); and precision force. [69] In this setting, ISR refers to the use of sensor and reporting technologies as well as those means employed in order to track and understand what enemy and friendly forces are doing.[70] This category encompasses what we currently call situational understanding. Next, C^4I, refers to those technologies and techniques by which the awareness of what is taking place in a specified area of interest is displayed, manipulated, processed, and analyzed to assist the commander in decision making; and, to convey those decisions in the form of orders and instructions rapidly, accurately, and reliably to combat forces.[71] The automated framework used to maintain

situational understanding must be able to accommodate changes in force allocation. Finally, Johnson and Libicki describe precision force to be all forces and weaponry employed to accomplish assigned missions. Johnson and Libicki emphasize that this goes beyond precision-guided munitions to encompass "the infantry as well as strategic bombers."[72] Since this monograph focuses on the battle command battle dynamic, precision force will be limited in scope to: those technologies which link sensors, C4I, and shooters in specific relationships defined by the commander in order to facilitate rapid response to enemy actions; and those technologies that provide feedback on the results of actions taken and their effectiveness. Figure 3 represents a simplistic visualization of the resultant advanced C^4I technology construct.

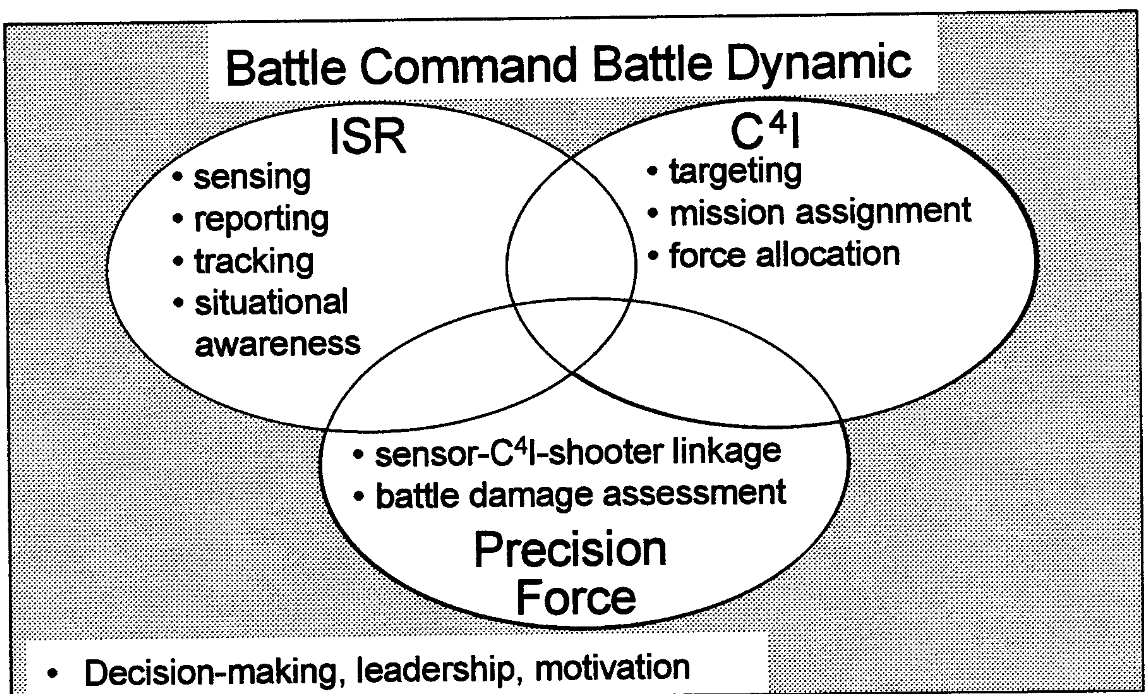


Figure 3. Advanced C^4I Technology Construct.

The ISR category of the Advanced C^4I Technology Construct encompasses four main technology areas: sensing, reporting, tracking, and situational understanding. The first

of these areas, sensing technology, is critical to the battle command battle dynamic because without a clear, current picture of the threat light infantry forces face, real-time planning and decision-making will be less effective in achieving the desired end-states associated with ongoing missions

Before proceeding, it would be appropriate to mention that information collected with battalion assets and processed into usable intelligence will continue to be augmented by intelligence data provided by resources outside the task force's command and control. Future urban environments will render most, if not all, of these external intelligence sources less effective to varying degrees. This is due mainly to the complexity of the terrain encountered in such environments and the compartmentalization and confusion created by buildings and non-combatant personnel operating in proximity to sensors and soldiers. For reasons explained in the introduction of this monograph, discussion concerning future ISR capability requirements in the early twenty-first century will be limited to those currently found or likely to be placed within a light infantry battalion task force.

Light infantry battalion task forces possess few sensor systems today, and currently rely on organic, attached, and supporting intelligence and electronic warfare (IEW) resources for nearly all combat information required to execute assigned missions. The principal IEW resources available to the battalion are its soldiers; those found in its maneuver companies and scout platoon.[73] The ability of soldiers to monitor, detect, and engage enemy forces is greatly enhanced by the plethora of low-level light-, thermal-, and infrared-observation devices now available. In addition, IEW technologies currently available to light infantry battalions include ground surveillance radar (GSR) and remotely

monitored battlefield sensor system (REMBASS). However, the former system would be ineffective in an urban environment. The latter system, while beneficial, does not exist in enough quantities to be of significant assistance; there are only five systems in a light infantry division today.[74]

Future sensing capability requirements will continue to include night observation devices (NODs) and weapon sighting systems. In the case of NODs, these devices have improved with time in terms of clarity, reduction in size and weight, and range of employment.[75] In addition, the capability to integrate NODs with assigned weapon system sights and situational understanding devices is needed in order to achieve a rapid and seamless interchange between these systems without compromising light discipline. The United States Army Infantry School (USAIS) Own The Night (OTN) Initiative has resulted in NODs being fielded down to nearly every soldier in a light infantry battalion. This trend should continue. In the case of weapon sighting systems which employ both low-level light and thermal technologies, these devices continue to improve the ability of their users to employ direct fire weapons during hours of darkness to the point where night time engagement distances are approaching daylight maximum effective ranges.[76] An ideal solution would be one multi-purpose sight capable of employing both low-level light and thermal technologies.

In urban environments, it is often very difficult, if not impossible, to disguise or hide sensors. Since they are mostly artificial, these devices are easily avoided or neutralized unless manned and protected. Future sensor technologies need to be designed to be either inconspicuous or not easily damaged or neutralized; both qualities are desirable. Feedback received from these sensors is often discrete, allowing only minimal data to be provided

(i.e., movement is detected, but there is no description of what is moving or whether or not it poses a threat). In the future, sensor capabilities must be designed to provide greater quantities and quality of information such as number of personnel, type or presence of munitions carried, identity or characteristics of personnel, and direction of movement. Audio and visual feedback sensors would be well suited generating these types of data, if issues of cost and numbers of sensors could be resolved. Finally, portable, hand-held devices that employ the latest "sniffing" technology are needed as a means to identify personnel that have recently handled ammunition or explosives, or who possibly have moved through certain types of areas, such as sewers, in order to further identify them as potentially hostile to U.S. forces.

The development of robotic ground sensors is ongoing; primarily being designed for open terrain and outdoors.[77] But such sensors only partially meet future requirements for sensors. Infantry forces also require robotic sensors that can move inside buildings, up stairs, and through windows or holes in walls. Size, cost, agility, survivability and multi-purpose utility are just some of the factors that would influence future design of robotic sensors. Robotic sensors do not necessarily have to be bulky structures. Lighter-than-air technologies that allow free floating video cameras or sensors to move through corridors or up stair wells while providing feedback to a remote station are a possible area of development.

In the early twenty-first century, human intelligence (HUMINT) will still be required and used to collect information. Envisioning that future Army deployments will be in countries where languages other than English are spoken, technologies that assist in translating foreign languages will be invaluable. Audio sensors, or "bugs", which relay

sounds back to monitoring stations, exist today but are not currently in the Army's inventory. These would be invaluable sources of intelligence when combined with HUMINT insertion and resources that can monitor and translate information collected. Concealment and camouflage would be important aspects in the design of such sensors.

The second technology area under the ISR category, reporting technology, encompasses how information gained through reconnaissance, surveillance, HUMINT, and other sources is relayed to a central processing center and returned or distributed as processed intelligence. The primary means of transmitting information on the battlefield today are voice, visual/audio signals, wire, radio, and messenger. Operations in urban areas will severely challenge all these means. Voice and audio signals are limited to close proximity between soldiers and are greatly affected by other sounds present during transmission. Likewise, visual signals are limited by line of sight, something greatly reduced in urban environments. Wire will allow transmission of information over long distances but is limited to static situations where force headquarters are stationary. This is not always the case. The use of existing phone lines along with portable phones provides an expedient means of communicating in urban areas and allows for a greater degree of freedom provided these lines are serviceable. Messenger transmission of information is perhaps the most reliable form of transmission but not always the most timely or the safest means to employ. Messengers travel at the speed of available conveyances. One worst case scenario that illustrates these points would be a situation in which a messenger must travel inside a building which has no power and therefore no lighting. The messenger must travel up twenty flights of stairs through an area that is not completely secure. It is

easy to conclude that radio and telecommunications technology (e.g., iridium cell phones) offer the fastest, safest, and most flexible means of transmitting information.

Urban environments, however, create problems for radio communications. According to Van Konynenburg, radio communications in urban areas suffer from urban propagation and noise problems. Urban propagation problems include shadowing (dead spots are caused by urban structures that block or absorb signals) and multi-path effects (fading of communications is caused by the reflection of signals off of urban terrain creating interference at the antenna location). Noise problems include man-made electrical noises concentrated at lower frequencies and mechanical noises caused by heavy industry or manufacturing.[78]

Future communications required by light infantry forces in urban terrain will include radio and telecommunications systems that provide the ability to transmit and receive information with high degrees of fidelity and reliability. Information will include voice, digital, and analog information, which must be transmitted clearly enough to allow for error-free processing by the receiving station.

The third technology area under the ISR category, tracking technology, encompasses the capability of storing, and updating information about enemy, neutral, and friendly forces. Computers today allow a virtually unlimited ability to store, manipulate, and update data, so it is difficult not to imagine the employment of automation systems in support of this technology area. The first question is, "What data do we use?" David Alberts, current director of the Advanced Concepts, Technologies and Information Strategies (ACTIS) Directorate at the National Defense University, offers the following answer.

> As noted, situational awareness is multi-dimensional. It includes knowing the current position, classification, identity, condition, and recent history of all items of military significance on the battlefield...It also can be said to include knowledge of the objectives, intentions, and plans of all players. Items of interest include strategic targets of both the conventional kind ...and unconventional kind...[79]

Unfortunately, knowing what data to use does not answer follow-on questions regarding how to get it or how to process it into usable intelligence. The means required to obtain the data depend on whether it is on friendly, neutral, or enemy forces. This is driven primarily by the reality that while friendly forces will cooperate with actions required to provide these data, neutral and enemy forces will not knowingly provide the same type of support.

The capability to obtain and track data from friendly forces has existed for a long time. Until recently, these data were obtained through routine reports prepared by units and submitted at specified times or when specific events occurred. In the future, these reports should be provided using automated capabilities. For example, the position, classification, and identity of individual soldiers could be encoded and placed in a small transmitter programmed to send a signal at specified times to a local receiving station, which would collect all such signals, store and forward these data for use as required. The local receiving station, in a secure position, would maintain these data for a period of time and be capable of providing data for use in displaying recent histories of friendly movement on individuals, groups, or the entire battalion task force.

The capability to obtain and track data on neutral or enemy forces has also existed for some time; hampered by the reality that neutral and enemy forces do not want their position, classification or identity to be known by forces hostile to their intentions. We have already discussed how soldiers and sensors are employed within a light infantry

battalion task force to obtain these data. We have also discussed the challenges posed by reporting data on enemy forces. The difficulty in tracking neutral and enemy forces lays primarily in the process used to collect and store data and allow for its manipulation and display. Capabilities are required that automate this process; capabilities which allow individuals to be "tagged", identified, located, and defined within a given battle space with these data being stored in order to provide the means to portray recent histories of their actions. An analogy to what has just been described would be air traffic control (ATC) systems. These systems employ a radar network to detect and track aircraft inside a specified air space. Aircraft carrying transponders emit a signal which allows them to be identified. This identity is fed into the ATC system and used to "tag" the aircraft. Aircraft without transponders are "tagged" as unidentified and tracked until identification is obtained. ATC systems enable air traffic controllers to control air traffic, to provide the basis for making decisions, and develop plans for coordinating air traffic in order to prevent accidents.

Urban environments will make tracking difficult as the technologies needed to detect individual movement inside buildings do not exist yet. Moreover, once individuals are detected within the urban battle space, their identity must be established. While techniques such as control measures and knowledge of neutral or enemy doctrine will allow some capacity for identification, these techniques are far from adequate. Here again, sensor technologies that allow for the ability to "tag" individuals will prove useful. A future tagging system for neutral or enemy force movements might be achieved using materials that stick to individuals and which radiate or reflect signals, in conjunction with a scanning system which automatically processes these signals to provide data on position.

Situational understanding technology is the fourth technological area in the ISR category. This area encompasses those technologies used to display and manipulate data in order to provide a clear understanding of friendly, neutral, and enemy force dispositions and actions within a specified battle space. The capability to rapidly extract and tailor data, display it in an easily understood mode, and do so while enhancing military operations and without violating operational security will be critical. This capability will require a high degree of variability among the many users of these data.

The capability to rapidly extract and tailor data critical for determining a course of action will be crucial. For soldiers operating in an urban environment during combat, requests for these data will need to be verbally initiated. It is doubtful that technologies will exist in the early twenty-first century that fully automate this data tailoring and processing capability. Consequently, there needs to be a data processing cell or center that takes requests for information, produces a desired product and rapidly transmits it to the requestor. Moreover, there needs to be a melding of military intelligence processing capabilities at lower levels and within light infantry units to provide the degree of timely and tailored data required. Ideally, this data processing cell should be located in a secure area far from the deployed unit, possibly even CONUS based. Employing communications reach back capabilities, such a cell would remain accessible and yet secure from direct threats. Barring this option, much of this activity could take place in the battalion tactical operations center. Currently, ABCS components have the capability to pull up detailed map displays and alter scale and color to provide requested information. These components must also be able to access street maps; floor plans; sewer, water, and power grid maps; subway tunnel maps, and other data bases in order to assist in analyzing

various lines of communication within a specified area. These data are not likely to be readily available for most third world countries, so they may have to be built rapidly using current technologies such as unmanned aerial vehicle (UAV) over-flights and scanning equipment to develop crude maps.

Displaying data in an easily understandable form will be a major challenge for combat and material developers designing future situational understanding displays; especially when displaying military operations in urban and complex terrain environments. This is because, unlike open terrain which allows for the usefulness of two-dimensional displays, an urban environment creates the need for a three dimensional display format. Ralph Peters made note of this when he stated:

> Even a 'digitized' soldier...will require different display structures in the observing command center. This is the classic three-dimensional chessboard at the tactical level.[80]

An excellent illustration of this problem can be observed in the motion picture, *Aliens II*.[81] In one scene, a Marine platoon is located in a building containing several stories. A Marine team leader is using a two-dimensional display which shows an "alien" to be in close proximity to a Marine soldier detached from the rest of the team; both are reflected as "dots" on the display. The detached Marine cannot see the "alien". As the "dots" merge indicating that the alien is almost at the detached Marine's location, the Marine team leader orders the detached Marine to move out of his current position. The Marine does so by jumping down a chute and landing directly in front of the "alien" he was attempting to evade. The problem with a two-dimensional display in this illustration is obvious. For light infantry forces, this problem is further exacerbated when considering how to achieved three dimensional effects in a heads-up display for infantrymen.

Displays must be capable of integration with other optical devices and usable under combat conditions without violating operation security. This requirement sounds simple, but given the large number of commercial firms involved in developing technology for the military, achieving seamless interoperability among various pieces of technology being developed for the Army is proving to be anything but simple. This problem was observed during one of the Army's recent Advanced Warfighting Experiments (AWE), Task Force XXI, which was conducted at the National Training Center, Fort Irwin, California during Rotation 96-07[82]. A typical infantry platoon leader during this rotation carried an AN/PVS-7B NOD during hours of darkness and a Thermal Weapons Sight (TWS), a sighting device to allow longer range observation of enemy movement and, when mounted to a weapon system, capable of facilitating accurate fire at night. Infantry platoon leaders also employed a situational understanding device called the Dismounted Soldier System (DSS), which allowed its user to see real time positioning of friendly and enemy forces on a digital map displayed on a liquid crystal display (LCD).

Switching between the NOD and TWS did not appear to be difficult, however, having to do so while moving and shooting created challenges for the user delaying his ability to focus and engage enemy targets. Switching between these devices and the DSS, however, proved to be highly disruptive to movement by temporarily reducing the user's night vision posture and by emitting a light signature that was easily observed under night conditions. As a consequence, whenever DSS was employed, its users had to view the DSS liquid crystal display (LCD) under a poncho to keep light from being observed by enemy forces. In some instances, DSS users openly viewed displays assuming risk that the signature emitted from the screen would not be detected.

The ability to know where you are, where other friendly units are, and where enemy forces are and what they are doing is important. Light forces, more than most, are forced in urban environments to operate in an environment of uncertainty. Their doctrine assumes very little is known and they operate accordingly. As has been stated already, knowing is not the final end state. Forces must be able to act on what they know, which means that they must be able to absorb, process, develop, decide, and disseminate information and instructions. This requires C^4I capabilities, which are discussed next.

The C^4I category of the Advanced C^4I Technology Construct encompasses three main technological areas: targeting, mission assignment, and force allocation. The first of these technological areas, targeting, addresses those technologies which assist in the process of identifying and selecting targets for engagement or action and programming available resources against these targets in accordance with standing guidance or instructions from the commander based on his assessment of the situation. While a light infantry battalion task force is normally supported by a broad array of combat support resources, direct application of such resources may be severely restricted in an urban environment as the desire for minimizing collateral damage will be high and the effectiveness of resources being employed will be questionable. Infantry forces will in many cases be restricted to direct fire weapons or remote controlled-sensor activated weapon systems. "Targeting" in urban areas may be more a function of analyzing areas of urban terrain or portions of buildings to determine which are key terrain and what advantages they afford the possessor. Future combat in urban environments will require the capability to model portions of an urban battle space; to analyze parameters such as line of sight distances,

building construction and composition, and resultant effects of specific munitions; and to war game the outcome of various courses of action.

The second technological area in the C^4I category, mission assignment, encompasses those technologies which aid in the command and control process by facilitating the preparation and transmittal of orders and coordinating instructions to subordinate elements. Some simple examples of this include the generation of brevity codes and use of pagers to trigger key actions. To minimize, if not eliminate altogether, any need for a keyboard, any device used to prepare orders ought to employ audio input technologies; those that allow a user to simply speak and then record that input in legible, typed form. The capability to rapidly assemble operation orders and disseminate them to subordinate elements will be just as important in the future as it is now. By capitalizing on a high level of situational understanding and a reliable system of communications in an urban environment, a common relevant picture[83] can be established and maintained. Such a picture of the battle space will facilitate parallel planning and anticipation of future missions. The means to convey this common relevant picture must possess the capacity to be interactive. A commander or operations officer at one end of a communications link ought to be able to draw or use a pointing device to create graphic symbols and control measures that are immediately viewed by a subordinate commander on the other end of that link. The subordinate commander ought to be able to post the location of newly discovered enemy force or obstacle locations or newly cleared routes through obstacles in a similar fashion.

The third technological area in the C^4I category, force allocation, encompasses the rapid ability to change task organization, support relationships and reconfigure combat

support and combat service support functions simultaneously in order to support changes in task organization. The capability to make seamless adjustments "on the move" will allow for rapid adjustments in urban environments against an uncooperative enemy force. While this seems simple, changes in task organization require the automation systems supporting a light infantry battalion to be reprogrammed to recognize the changes, which not only include data on subordinate units, but also nodal addresses and instructions that facilitate where information flows in a network being employed to maintain a common relevant picture. Recent experiences during the Task Force XXI AWE at the National Training Center in March 1997 bore this out. During the experiment, changes in task organization required a shutdown and restart procedure within the brigade combat team's Army's Battle Command System, or ABCS, and all Appliqué and DSS systems.[84] This procedure took between thirty minutes and two hours to accomplish and was limited to pre-determined task organization changes. No other modifications to the pre-determined task organization were possible. Such action was simply not within the capabilities of the technology employed.

The Precision Force category of the Advanced C^4I encompasses two main technological areas: sensor-C^4I-shooter linkage, and battle damage assessment (BDA). The first of these technological areas, sensor-C^4I-shooter linkage, consists of those technologies which enable the commander to minimize the target detection-decision-execute timeframe. Current examples of this type of "system" include quick fire nets for artillery fires in support of key targets. Light infantry battalions require the capability to establish sensor-C^4I-shooter linkages within the ABCS system the Army ultimately decides to develop and field. Specific targets to be selected for predetermined engagement are

problematic, however, within urban environments, likely targets will include key electrical, communications, and supply nodes supporting enemy operations.

The second technological area within the Precision Force category is battle damage assessment. This technological area encompasses the capability to assess the effects of friendly force actions on enemy forces, facilities, and capabilities. Often, phases in a plan are triggered by the attainment of certain specified effects on an enemy force or capability. Normally, friendly forces will dedicate a portion of their assets to making an assessment of how effective these have been.. Light infantry forces must be able to gain assessments of results produced by their actions within their assigned area of operation.

One final caveat to the above requirements remains to be stated. It is probably the most important. A soldier's load has its limits. Whatever is given to a light infantry soldier must be worth the cost of carrying it. Weight has its price and if any piece of technology given to a soldier fails to justify the price of carrying it, it may not be carried for long. James Dunnigan, in *Digital Soldiers*, makes note of these points.

> The problem is that the infantry have to carry all of their gear and, once the shooting starts, your average [infantryman]...wants to travel light. New technology usually weighs more than it's worth for a foot soldier[85]....The agility that makes the individual infantryman so nimble and useful on the battlefield is canceled out if you try to load [him] down with all manner of well-meaning but weighty gadgets.[86]...war is a deadly business, and most of the troops will either find a way to use [a new piece of technology], or else the battlefield will be littered with them. The troops do have a tendency to simply discard what doesn't work. When it's a matter of life and death, no one hangs on to some[one's]...pet idea.[87]

Table 1, on the following page (page 38), summarizes the technological capability requirements identified in this section.

#	Category	Required Capability
1	ISR	Continued improvements to NODs through reduction in size, weight, and range of employment
2	ISR	Continued fielding of NODs to all soldiers in light infantry units
3	ISR	Capability to integrate NODs, weapon sights, and situational understanding devices to enable rapid, seamless shifting between sight and information pictures without compromising light discipline
4	ISR	Continued improvement to weapon sighting systems to night time engagement ranges which approach day time engagement ranges
5	ISR	Capability to employ a full range of sensors designed to be inconspicuous and/or difficult to damage or neutralize
6	ISR	Capability to employ robotic sensors that move inside buildings, up stairs, through holes in walls and windows.
7	ISR	Capability to translate foreign languages
8	ISR	Capability to employ audio sensors, or "bugs", that relay sound
9	ISR	Capability to employ enhanced radio and tele-communications equipment that operate in urban areas without degradation
10	ISR	Capability to receive data from automated and manual sources on friendly, neutral, & enemy forces; store, update, and relay as required
11	ISR	Capability to detect, locate, and "tag" unidentified individuals in urban environments; monitor position & movement; store data and update as required
12	ISR	Capability to process data and rapidly display data upon request
13	ISR	Capability to display data in either two- or three-dimensional format
14	C^4I	Capability to assist in process of identifying and selecting targets for engagement or action
15	C^4I	Capability to model battle space, analyze selected parameters, and wargame various courses of action
16	C^4I	Capability to prepare operations orders using audio input and rapidly disseminate them to subordinate elements
17	C^4I	Capability to employ a graphic display that allows direct interaction between two distant points using tactile input to display graphics
18	C^4I	Capability to facilitate parallel planning
19	C^4I	Capability to rapidly tailor force data base "on the move" to reflect changes in task organizations
20	PF	Capability to establish sensor-C^4I-shooter linkages for rapid engagements as required
21	PF	Capability to assess battle damage as a result of friendly actions

Table 1. Required Advanced C^4I Capabilities

IV. Shortfalls in Light Infantry Force Battle Command Technologies

In the previous section, twenty-one advanced C^4I capabilities were identified which were required by light infantry forces, battalion and below, in order to realize enhanced battle command while operating in urban environments in the early twenty-first century. In this section, related battle command technologies the Army currently schedules in its combat development programs or for which the Army possesses recent experimental feedback are assessed in order to determine which of these capabilities are being pursued. The results of this assessment will determine whether there are shortfalls in the development of future capabilities for the light infantry force.

Three primary sources of information are employed. These include Infantry Conference "State of the Infantry" briefings for 1997 and 1998; combat development information located at Fort Benning's Home Page on the Internet and maintained by the United State Army Infantry School (Infantry School) at Fort Benning, Georgia; and materials and experiences collected by this author while serving as the senior subject matter expert for the light infantry battalion task force observation team during the Army's Task Force XXI Advanced Warfighting Experiment at the National Training Center in March of 1997.

Table 2, Current Infantry Technology Programs (pages 45-47), contains a list of ten program areas currently supported by the Infantry School. This table also reflects the priority[88] for development of the technologies associated with each of these programs along with a concise description of what each program entails. Of the ten program areas, four are directly related to enhancement of the battle command battle dynamic for the light

infantry force. These program areas include Land Warrior (LW), Own-The Night (OTN), Directed Energy (sensors only), and Robotics. (See Table 2)

Table 3, Task Force XXI (TF XXI) Advanced Warfighting Experiment (AWE) Infantry C2 Initiatives (page 47), contains a list of 18 initiatives involving light infantry C2 technologies which were experimented with during TF XXI AWE. (See Table 3) These were included in an array of more than 85 initiatives experimented with during this AWE.[89] Of a total of 24 initiatives which directly involved the light infantry force, 18 were related to establishing and maintaining situational understanding. The high degree of effort spent in pursuit of digitization and gaining situational understanding of the battlefield was characteristic of the TF XXI AWE.

A review of battle command-related technologies currently under development within the Infantry School and battle command-related initiatives observed during the TF XXI AWE with twenty-one required advanced C^4I capabilities established in Section III of this monograph yielded the results illustrated in Table 4, Assessment of Capability Development Efforts (page 48). What Table 4 illustrates is whether current programs and initiatives are addressing the development of those future technologies required by light infantry forces, battalion and below, in order to optimize their ability to operate in the urban environments of the early twenty-first century. Several observations can be made.

First, continued efforts to improve the performance, reduce the size and weight, and increase the range of NODs for both individuals and weapons are noted. Development of thermal weapon sighting systems serve to enhance the capability of infantrymen to "own the night", not only from the perspective of being able to engage and kill targets under night time conditions, but also from the standpoint of enhancing their ability to conduct

night time surveillance more effectively. The integration of these devices into a total fighting system which allows for the soldier to move to and from a situational understanding display seamlessly and without degradation of either total night vision or operations security still requires work.

Second, there is a notable lack of sensor design and adaptation for military purposes. While the infantry force has access to REMBASS and there appears to be some effort in developing a second system, the Platoon Early Warning Device, these devices are not numerous enough to optimize the ability of infantrymen to conduct surveillance in urban environments. Moreover, high cost and susceptibility to detection and destruction if left unprotected mean these devices will seldom, if ever, be employed in an urban environment. Robotics, a popular research area more than a decade ago, has seen few new initiatives that would support infantrymen in urban terrain and remains largely undeveloped.

Third, efforts aimed at providing smaller, more secure communication devices to infantrymen are noted. The TF XXI AWE saw several new pieces of technology being evaluated which were specifically designed for light infantry forces. But there are still many problems associated with this equipment such as line of sight limitations, relatively short range capabilities, and short battery power and duration capabilities. The urban environments of the future may reduce range requirements, but will present new problems involving noise and static as previously discussed.

Fourth, the Army's bold investment in experimental technologies which attempt to put situational understanding devices into the hands of individual soldiers down to squad leader level is readily apparent. The DSS technology employed during TF XXI AWE

tested situational understanding concepts and provided a unique look at some of the capabilities offered by this new technology. Though the concepts are similar, the technology being developed for Land Warrior seeks to remedy many of the faults found with DSS. These include low operational and situational understanding rates; fragility of equipment components; awkward configuration; bulk and weight of system too high; requirements for batteries, which did not last long when the system was in use; display screen brightness; heavy reliance on communications equipment that was itself highly unreliable in rugged terrain.[90] These problems present some tough challenges that must be overcome before light infantry forces can truly possess the capability for situational understanding at the soldier level.

The Army is also aggressively pursuing the development of technologies that integrate major battle functions by sharing critical information and enabling data to be presented and processed on demand. The Army is heavily resourcing development of the Army Battle Command System (ABCS) and its sub-component systems. These systems already possess the capability to send and receive large amounts of data and to process these data and to display them as requested by the user. Several shortcomings, which must still be addressed, include: inability to receive data on enemy force locations from sensors and post it automatically; data displays are two-dimensional, which limit their ability to convey situations that are three-dimensional (e.g., force deployments inside a multi-story building); operation orders must still be prepared using keypad entry techniques; communication links to all parts of the tactical Internet are still highly affected by current batch of radios supporting those links; no software developed that assists in modeling or wargaming plans development though there are some terrain analysis programs that assess

visibility; targets must still be analyzed and selected manually as there are no programs that do this; graphics displays are not set up to allow tactile interaction between two separate stations nor can distance stations "chat" with each other as is routinely done on the Internet; interoperability among sub-components is not totally achieved; and levels of reliability are not as high as they should be which results in the need to maintain secondary manual systems within a tactical operations center as back-ups.

Of the above shortcomings, the most critical is the inability to "tag" and automate entry of data on enemy forces. Currently, these data must be entered manually and adjusted manually. During the TF XXI AWE, this requirement placed a tremendous workload on the battalion S2, whose small staff had only unit spot reports to go on which were often old or inaccurate. In the end, the S2 staff was not able to keep up with this requirement. True situational understanding will not be achieved until a system can be created which effectively shows both friendly and enemy forces accurately and in a timely manner on one display device.

Fifth, efforts aimed at developing new technologies which tie sensors through C^4I systems to shooters for rapid execution of fires are noted. Within the Infantry School, efforts embodied in the MFCS will allow the rapid dissemination of digital fire commands from battalion fire direction center (FDC) to the guns bypassing the need for verbal relays. The "sensors" in this instance are primarily forward observers, however. Land Warrior capabilities will turn virtually every soldier into a forward observer by given him the ability to determine the exact range to a target he observes and instantly relaying what he sees to the FDC for immediate response. In urban environments, the ability to gain situational understanding at the individual level will enable light infantry forces to operate from a

common relevant picture where leaders can direct the action of units and soldiers on the ground to concentrate at critical points on the battlefield. Leaders, who assess the digital information they receive from infantrymen located in the battle space, will be able to maneuver, or "shoot", other infantry forces at selected points concentrating their fires to achieve the defeat or destruction of enemy forces.

Finally, it is noted that the capability to assess battle damage remains predominantly with soldiers who will operate in and on the battlefield. Sensors and aerial vehicles will enhance this capability. Currently, technologies which enable the capability to assess battle damage rapidly across a battlefield or in an urban environment are not being developed.

Program Area	Priority	Description
Land Warrior[91]	1	Program seeks to develop a first-generation integrated fighting system for dismounted combat soldiers. Land Warrior includes: • Computer/radio sub-system with Global Positioning System receiver, VHF and UHF radios, and video capture capability • Integrated Helmet Assembly sub-system with heads-up display and image intensifier for night operations • Weapons sub-system with thermal weapon sight, close combat optic, video camera, laser range-finder/digital compass, and an infrared aiming light • Protective Clothing and Equipment sub-system with load carrying equipment, body armor, a chemical/biological mask, and laser detector • Software sub-system supporting the soldier's core battlefield functions, display management, and mission equipment and supply
Infantry Fighting Vehicles[92]	2	Program seeking to modernize and enhance the combat vehicle which provides mechanized infantry units the means to maneuver mounted in the battlefield while providing tremendous firepower and force protection capabilities. Several technology upgrades are scheduled for completion by FY2000: • Embedded digitization • 2nd Generation FLIR • Commander's Independent Viewer • Ballistic Fire Control, Auto-track • 3-D Squad Screen • Other enhancements
Anti-Armor[93]	3	Program seeking to develop five anti-tank weapon systems for fielding into the Army inventory. Includes: • Javelin: Hand held, soldier fired, fire-and-forget anti-tank missile system; successor to DRAGON • ITAS: Improved Target Acquisition System for TOW; improvements include installation of 2d Generation FLIR, laser range finder, increased P_k, integrated day/night sight, auto-boresight, & others • FOTT: Follow On To TOW • EFOGM: Enhanced Fiber Guided Missile System • LOSAT: Line Of Sight Anti-Tank Missile System

Table 2. Current Infantry Technology Programs

Program Area	Priority	Description
Own-The-Night[94]	4	Program seeking to enhance and field technologies which allow the infantry to fight at night. Includes: • Night Vision Goggles: AN/PVS-7D, AN/PVS-14 • Night Vision Sights: AN/PVS-4, AN/TVS-5 • IR Aiming Light: AN/PAQ-4C, AN/PEQ-2 • Sniper Sight: Leopold Day Sight, Sniper Day/Night Sight AN/PVW-10
Small Arms[95]	5	Program seeking to develop operational requirements for all small arms weapons systems and associated ammunition. Current projects include: • XM107 Long Range Sniper Rifle • M240B Medium Machine Gun • M4 Carbine, XM145 Machine Gun Optic • M68 Close Combat Optic • MK19 Grenade Machine Gun • Small Arms Master Plan • Objective Individual Combat Weapon • Objective Crew Served Weapon • Objective Sniper Weapon • various ammo and non-lethal weapons programs
Soldier Modernization[96]	6	Program seeking to enhance soldier combat effectiveness, lighten weapons and make them more lethal, improve soldier items and quality of life, and lighten the soldier's load. Includes: • Body Armor and Load System • Advanced Tactical parachute System • Laser Protection
Mortar System[97]	7	Program seeking to enhance current mortar systems and develop new mortar systems to provide improved indirect fire support to infantry units. Includes: • XM95 Mortar Fire Control System (MFCS) • M30 Mortar Ballistic Computer (MBC) • Precision Guided Mortar Munition (PGMM) • 60 mm, 81 mm, and 120 mm Mortars • Sub-caliber training devices
Mounted Systems, Other[98]	8	Program seeking to develop mounted Infantry requirements, enhance the performance of existing combat vehicles, and develop future mounted concepts. Includes: Bradley Family of Vehicles, M113 Family of Vehicles, Future Infantry Vehicle

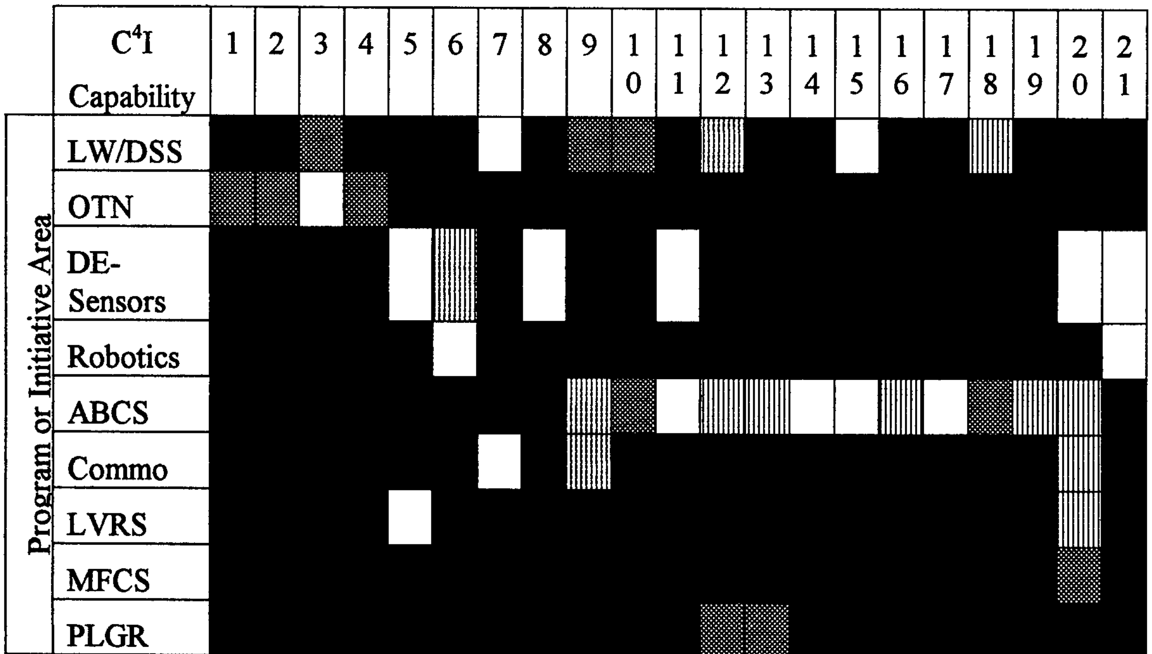
Table 2. Current Infantry Technology Programs (Continued)

Program Area	Priority	Description
Directed Energy[99]	9	Program seeking to develop requirements for all night vision, directed energy, tactical unmanned systems and robotics, tactical sensor systems, combat identification systems, and Infantry input to other branch systems. Includes: • Combat Identification for the Dismounted Soldier • Platoon Early Warning Device II • Shortstop Electronic Protection System (AN/VLQ-V) • Own The Night Programs (See Priority 4 entry) • Target Location and Observation System (TLOS) • Robotics Programs (See Priority 10 entry)
Robotics[100]	10	Program seeking to develop requirements for robotics systems to enhance infantry operations on the battlefield. Includes the Tactical Unmanned Vehicle (TUV), which performs reconnaissance, surveillance, target acquisition, and NBC detection tasks.

Table 2. Current Infantry Technology Programs (Continued)

Task Force XXI (TF XXI) Advance Warfighting Experiment (AWE) Infantry C2 Initiatives[101]	
Area	Initiative
ABCS	• Advanced Field Artillery Tactical Data System (AFATDS) • All Source Analysis System – Remote Workstation (ASAS-RW) • Appliqué • Direct Broadcast Satellite/Battlefield Awareness Data Dissemination • Forward Area Air Defense Command and Control (FAADC2I) • Lightweight Tactical Operations Center (LTOC) • Maneuver Control System/Phoenix (MCS/P) • Network Management Tool – Brigade and Below (NMT-B2) • Surrogate Data Radio (SDR) • System Integration Van (SIV)
Commo	• Enhanced Position Location and Reporting System (EPLRS) • Handheld SINCGARS/Light INC (LINC) • Single Channel Ground and Airborne Radio System (SINCGARS) SIP/INC
DSS	• Dismounted System Soldier (DSS)
LVRS	• Lightweight Video Reconnaissance System (LVRS)
MFCS	• Mortar Fire Control System (MFCS)
OTN	• Own The Night (OTN)
PLGR	• Precision Lightweight Global Positioning Systems Receive (PLGR)

Table 3. Future Light Infantry C^4I Technologies Explored During TF XXI AWE



Legend: Square unshaded – Capability not being programmed or experimented with
Square filled with stripes – Capability being developed to small degree
Square filled with grid – Capability being developed to large degree
Square completely black – Program or Initiative not applicable to capability

Note 1: C4I capability numbers correspond to those assigned in Table 1.

Note 2: Program and Initiative Areas correspond to those assigned in Tables 2 and 3. LW and DSS have been combined, since DSS concepts have been incorporated into LW. OTN program and initiative areas have been combined.

Table 4. Assessment of Capability Development Efforts

V. Conclusion

Early twenty-first century battlefield urban environments, in which our future light infantry forces will operate, pose tremendous battle command challenges. Due to their complexity, the soldiers required to conduct them, and their potential for producing many casualties, military operations in urban terrain have generally been avoided whenever possible. This research concludes that military operations in urban terrain will be less and less avoidable in the future. Ralph Peters reflected on this dilemma when he wrote, "We declare that only fools fight in cities...but in the next century...we will not be able to avoid urban deployments short of war and even full-scale city combat."[102] Current trends in military operations bear this out.

Unwilling to confront Unites States military forces on open terrain, some opponents will seek, instead, to oppose America's vital interests through the use of asymmetric methods; methods against which U.S. forces remain compelled by American values and interests to act with restraint in order to avert conflict escalation or the accidental taking of life or destruction of property. Moreover, other opponents will surface who will not be afraid to confront U.S. forces in their own countries on terms unfavorable to our forces, even though they apply more conventional means. In most instances, such opponents will seldom stand out or present a target. Instead, they will blend in with non-combatants thus becoming indistinguishable from the masses of urban population in which they operate.

Urban terrain presents its own set of challenges, both to those forces that must operate in it and to the technologies these forces employ. The complexity of urban terrain, which severely limits battlefield observation and fields of fire, and the degrading effects it has on

command and control, and communication technologies serve to frame the setting against which future C^4I technologies must be designed if battle command is to be optimized.

This paper identified twenty-one advanced C^4I capabilities required in order to optimize battle command performance of light infantry forces, battalion and below, in the urban battlefields of the early twenty-first century. These capabilities fell within a construct which included three areas: ISR, C^4I, and precision fires. If achieved, these capabilities would, in turn, enable infantry battalion-and-below commanders and their staffs to: accurately and completely see the battlefield; achieve and maintain situational understanding; share a uniform battlefield common relevant picture; rapidly develop and decide on a course of action as required; and send decisions and related instructions, in the form of orders, to forces throughout the battlefield.

Advanced C^4I capability requirements identified as a result of this research included: continued improvements to night observation devices and weapon sighting systems and the integration of these devices into a single system that allows the user to also view a situational display that does not degrade night vision or emit a signature violating light discipline; a broad array of unobtrusive sensors to include robotic and audio sensing devices for employment in urban environments; a system of "tagging" and tracking enemy and neutral force personnel; continued development and refinement of the Army Battle Command System and its components to achieve reliable situational understanding; the ability to display three dimensional force dispositions; the ability to allow tactile interaction between two locations on the display; and the capacity to assist in the development, production, and rapid dissemination of combat orders. Also included were: the capability to rapidly tailor the force data base on the move; the capability to establish sensor-C4I-

shooter linkages for rapid engagement; and the capability to assess battle damage as a result of friendly actions.

This research determined that the Army in general and the Infantry School in particular are already aggressively pursuing many of the C4I technologies that will enable the above capabilities. However, several shortfalls in the development and experimentation arena still exist. Continued work on integrating situational understanding displays into a soldier system that will allow seamless transfer between observation device, weapon sight, and display is required. There is a noticeable lack of sensor technology development and adaptation for military operations in urban environments. Development of smaller, more reliable communications devices was noted, but must still overcome the challenges presented when operating in complex, urban environments. Reliable, effective communication means are imperative if infantry forces are ever to achieve situational understanding in urban environments. The Army's efforts to develop ABCS are on track, but must continue to provide enhanced planning, analysis, and interactive capabilities. Most critical – technologies are required that will allow both friendly and enemy forces to be accurately displayed in real time on one display. Technologies being developed with Land Warrior will enable sensor-to-C4I-to-shooter linkages to become a reality, but much work is still required before this can happen. Lastly, there are no efforts currently underway to develop technologies that will assist in battle damage assessment as a result of friendly force actions. These shortfalls must be addressed if light infantry battalion-and-below battle command is to be optimized in the expected operating environments of the early twenty-first century.

Of the above technologies, those considered to be high pay off technologies are those which most directly aid the commander and his staff in achieving situational understanding and in the formation and transmittal of plans and orders to subordinates. These technologies are, in order: (1) technologies that will allow both friendly and enemy forces to be accurately displayed in real time on one display; (2) smaller, more reliable communications devices capable of operating in complex, urban environments; (3) technologies which provide enhanced planning, analysis, and interactive capabilities; and (4) integrating situational understanding displays into a soldier system that will allow seamless transfer between observation device, weapon sight, and display.[103]

Endnotes

[1] Sullivan, Gordon R., and Anthony M. Coroalles, "Seeing the Elephant: Leading America's Army into the 21st Century," in The Collected Works of the Thirty-second Chief of Staff, United States Army, (Carlisle, Pennsylvania: US Army Military History Institute, 1995), 407-415.

[2] Ibid., 408.

[3] Ibid., 410.

[4] Ibid., 411.

[5] Ibid., 415.

[6] Naylor, Sean D., "General: Technology is no substitute for troops," Air Force Times, (3 March 97), 26. General Sheehan expressed this concern during an Association of the United States Army (AUSA) symposium held at Orlando, Florida 11 February 1997.

[7] Wagner, Robert F., "Modest proposals for the Army," Army Times, (16 November 1998), 31.

[8] Naylor, Sean D., "Technology may not be the whole answer." Army Times, (7 September 98), 26. Major General Scales was responsible for the initial development of TRADOC's Army After Next project in 1996. General Scales made these statements during a seminar titled "Emerging Operational Concepts in the 21st Century Strategic Environment," held at the University of South Carolina in Columbia on 12 August 1998.

[9] Pearton, Maurice, Diplomacy, War and Technology Since 1830, (Lawrence, Kansas: University Press of Kansas, 1984), 248-9.

[10] Doughty, Robert A., The Seeds of Disaster: The Development of French Army Doctrine 1919-1939, (Hamden, Connecticut: Archon Book, 1985), 184.

[11] Ibid., 188.

[12] Ibid., 3-3 to 3-4.

[13] Leonhard, Robert R., The Principles of War for the Information Age, (Novato, California: Presidio Press, 1998), 40.

[14] Johnson, Stuart E., and Martin C. Libicki, eds., Dominant Battlespace Knowledge: The Winning Edge, (Washington, D.C.: National Defense University Press, October 1995), 4.

[15] There are five "types" of Infantry forces in the Army today. These are: light infantry, mechanized infantry, airborne infantry, air assault infantry, and ranger.

[16] Dunnigan, James F., Digital Soldiers: The Evolution of High-Tech Weapons and Tomorrow's Brave New Battlefield, (New York, New York: St. Martin's Press, October 1996), 27.

[17] Ibid., 36.

[18] Jones, Brian D., Force XXI: What are the risks of building a high-tech, narrowly-focused Army?, (Fort Leavenworth, Kansas: School of Advanced Military Studies, 23 May 1996), 43.

[19] Ibid., 42. The acronym "WMD" stands for "weapons of mass destruction."

[20] Guilmartin, John F., Jr., "Technology and Asymmetrics in Modern Warfare." in Challenging the United States Symmetrically and Asymmetrically: Can America be Defeated?, ed. Lloyd J. Matthews, (Carlisle, Pennsylvania: Strategic Studies Institute, July 1998), 42.

[21] Ibid., 33.

[22] Ibid., 34.

[23] TRADOC Pamphlet 525-5, Force XXI Operations, This pamphlet is current being rewritten. A draft is in circulation.

[24] Ibid., i.

[25] Ibid., 3-24.

[26] Ibid., 2-1 to 2-2.

[27] Department of the Army Brochure, America's Army...into the 21st Century, (Washington, D.C.: Department of the Army), 2. The figure of 27 major deployments is as of April 1996.

[28] Department of the Army Brochure, Army Vision 2010, (Washington, D.C.: Department of the Army), 5. Figure 1 is a modification of the chart illustrations contained in this reference. It adopts the Spectrum of Combat-Spectrum of Peace construct therein and adds to it the number of operations U.S. Army forces have deployed in support of each mission type during the period 1990 to 1996. The total number of deployments -- 37 -- differs from the earlier number stated -- 27 -- due consolidation of missions on the part of the authors. The specific listing of missions conducted by mission type is as follows.

Civil Support: Los Angeles Riots (1992)
Disaster Relief: Typhoon Iniki (1992), Hurricane Andrew (1992), Midwest Floods (1993)
Environmental Operations: Western Firefighting (1994)
Humanitarian Assistance: GTMO/Haiti Refugees (1991-93), Cuban Migrant Opns (1994), Somolia Restore Hope (1992-94), Croatia Provide Promise (1993-96), Rwanda Support Hope (1994), Russia Provide Hope (1994), Iraq Provide Comfort (1991-99)
Peace Building: Macedonia Able Sentry (1992-99)
Nation Assistance: Bangladesh Sea Angel (1991), Panama Safe Haven (1994)
Peace Keeping: Haiti Uphold Democracy (1994), Sinai MNF (1982-99), Saudi Arabia Desert Shield (1990-91), Kuwait Vigilant Warrior (1994), Kuwait Vigilant Sentinel (1995), Bosnia Deny Flight (1993-96)
Non-combatant Evacuation Operations: Sierra Leone (1992), Liberia (1990, 1992, 1996), Philippines Pinatubo (1991), Haiti (1991, 1994), Somolia (1991, 1994)
Sanctions Enforcement: Iraq Southern Watch (1991)
Peace Enforcement: Bosnia Joint Endeavor (1995-96), Bosnia Joint Guard (1997-98), Somolia UNISOM II (1993)
Combatting Terrorism: Deliberate Force (1995)
Limited Conventional Conflict: Panama Just Cause (1989-90)
Regional Conventional Conflict: Kuwait Desert Storm (1991)

[29] Department of the Army, Field Manual 100-5, Operations, (Washington, D.C.: Department of the Army, 1986), 4. The Army has moved away from using this term and, in its 1993 version of this manual, now uses the phrase, "Operations Other Than War", or OOTW. Our doctrine pertaining to OOTW is still shifting. This phrase is currently being considered for change to "Stability and Support Operations" or SASO. Although this last phrase has not yet been approved as doctrine, it is already used in some academic and doctrine circles within the Army.

[30] Department of the Army Brochure, America's Army, 3-5.

[31] A National Security Strategy for a New Century, (Washington. D.C.: The White House, October 1998), iii.

[32] TRADOC Pamphlet 525-5, Force XXI Operations, 1-1.

[33] Metz, Steven, "Which Army After Next? The Strategic Implications of Alternative Futures," Parameters. (Vol XXVII. No 3; Autumn 1997), 15. Dr. Metz is the Henry L. Stimson Professor of Military Science at the U.S. Army War College and an analyst at the Strategic Studies Institute. He is the author of more than 50 articles and monographs on world politics and national security affairs.

[34] TRADOC Pamphlet 525-5, Force XXI Operations, 2-10.

[35] "Union of Soviet Socialist Republics," in Academic American Encyclopedia (1995 Grolier Multimedia Encyclopedia Version, copyright (c) 1995 Grolier, Inc. Danbury, CT) [CD-ROM]. Contrary to popular sentiment, the Soviet Union did not cease to be a military threat when the Berlin Wall came down in 1989. While Gorbachev allowed Soviet control over Eastern Europe to slip away, it was not until December 1991, after the leaders of Russia, Ukraine, and Belarus declared that a Commonwealth of Independent States would replace the Union of Soviet Socialist Republics, that Gorbachev resigned and the Soviet Union came to an end.

[36] Huntington, Samuel P., The Clash of Civilizations and the Remaking of World Order, (New York, New York: Simon and Schuster, 1996), 31.

[37] TRADOC Pamphlet 525-5, Force XXI Operations, 2-3.

[38] Ibid.

[39] A non-governmental organization (NGO) is a transnational organization of private citizens that maintains a consultative status with the Economic and Social Council of the United Nations. NGOs may be professional associations, foundations, multinational businesses, or simply groups with a common interest in humanitarian assistance activities (development and relief). NGO is a term normally used by non-US organizations and includes agencies such as: Concern Worldwide Limited and Save The Children Fund. A private voluntary organization (PVO) is a non-profit humanitarian assistance organization involved in development and relief activities. PVOs are normally US-based. PVO is often used synonymously with the term NGO and includes agencies such as: World Vision and American Red Cross. Other governmental agencies (OGA) include agencies with which the Department of Defense has frequent interaction or that a deployed joint task force may encounter during the course of contingency operations. Examples of OGAs include: Department of Justice and Department of State. For a comprehensive listing of these organizations, refer to Joint Publication 3-08, *Interagency Coordination During Joint Operations*.

[40] TRADOC Pamphlet 525-5, Force XXI Operations, 2-4.

[41] Ibid.

[42] Ibid.

[43] Bowden, Mark, "Black Hawk Down," Philadelphia Online. (Philadelphia, Pennsylvania: Philadelphia Newspapers Inc., 1997), Online. (http://www.phillynews.com/newslibrary/newslib_pi.html/ (10 January 1998)) Mark Bowden, staff writer for the Inquirer, drafted a series of articles titled, "Black Hawk Down", from 16 November 1997 to 14 December 1997, which provide an excellent documentary on U.S. light infantry actions in Mogadishu, Somalia. These actions ultimately resulted in the loss of national support for continued American military force presence in Somolia. In the aftermath of

the firefight in Mogadishu and the televised viewing of an American service member body being dragged through the streets of Mogadishu, President Clinton decided to withdraw all U.S. military forces from the United Nations mission in Somolia

[44] TRADOC Pamphlet 525-5, Force XXI Operations, 2-4.

[45] Ibid.

[46] Ibid.

[47] Peters, Ralph, "Our Soldiers, Their Cities," in Parameters, (Spring 1996), 45.

[48] Kaplan, Robert D., "The Coming Anarchy," in The Atlantic Monthly, (February 1994), 46.

[49] Bunker, Robert J., Five-Dimensional (Cyber) Warfighting: Can the Army After Next be Defeated Through Complex Concepts and Technologies, (Carlisle, Pennsylvania: Strategic Studies Institute, 10 March 1998), 1.

[50] Dunlap, Charles J., Jr., "21st Century Land Warfare: Four Dangerous Myths," in Parameters (Vol. XXVII, No. 3; Autumn 1997), 28.

[51] Ibid., 35.

[52] Glenn, Russell, "Marching Under Darkening Skies: The American Military and the Impending Urban Operations Threat - A Status Check," (Santa Monica: The RAND Corporation, March 1998), 3.

[53] Ibid., 2.

[54] Peters, Ralph, "Our Soldiers, Their Cities," 43.

[55] Ibid.

[56] Van Konynenburg, Matt, The Urban Century: Developing World Urban Trends and Possible Factors Affecting Military Operations, (Quantico, Virginia: Marine Corps Intelligence Agency, Document Number: MCIA-1586-003-97, November 1997), 1.

[57] Ibid.

[58] Ibid., 3.

[59] Gompert, David C., "Global Environment," in 1998 Strategic Assessment: Engaging Power for Peace, ed. Hans Binnendijk, (Fort McNair, Washington, D.C.: Institute for National Strategic Studies, National Defense University), 8.

[60] See remarks at Endnote 43.

[61] Matthews, Lloyd J., "Symmetries and Asymmetries - A Historical Perspective," in Challenging the United States Symmetrically and Asymmetrically: Can America be Defeated?, ed. Lloyd J. Matthews, (Carlisle, Pennsylvania: Strategic Studies Institute, July 1998), 20.

[62] Van Konynenburg, Matt, "The Urban Century", pg. 6.

[63] Ibid., 7.

[64] Ibid., 8.

[65] Naylor, Sean D., "General: Technology is no substitute for troops," 26. See also remarks at Endnote 6.

[66] Peters, Ralph. "Our Soldiers, Their Cities.", 45.

[67] See remarks at Endnote 8.

[68] Arquilla, John, "The Strategic Importance of Information Dominance," in Strategic Review, (Summer 1994), 25.

[69] Johnson, Stuart E., and Martin C. Libicki, eds., Dominant Battlespace Knowledge: The Winning Edge, 4-5.

[70] Ibid.

[71] Ibid.

[72] Ibid., 5.

[73] Department of the Army, Field Manual 34-80, Brigade and Battalion Intelligence and Electronic Warfare Operations, (Washington, D.C.: Headquarters, Department of the Army, April 1993), 2-1 to 2-2.

[74] Tactical Commanders Development Course Battle Book, (Fort Leavenworth, Kansas: United States Army Command and General Staff College), I-13.

[75] Hughes, Doug, Monocular Night Vision Device (MNVD) – Fact Sheet, (Fort Benning, Georgia: Directorate of Combat Developments, United States Army Infantry School, 11 June 1997). Future range-of-vision requirements being designed for the MNVD are 150 meters under starlight conditions, and 290 meters under ¼ moonlight conditions. One of its predecessors, the AN/PVS-4, had a planning range of 75 meters under starlight conditions and 150 meters under moonlight conditions.

[76] McGlown, Dave., Electronic and Special Developments Division: Current Projects, (Directorate of Combat Developments, United States Army Infantry School, Fort Benning, Georgia: United States Army Infantry Center Home Page), Online (http://www-benning.army.mil/dcd/esdd.htm/ 10 April 1999), 1. The Family of Thermal Weapon Sights will include a lightweight thermal sight for individual weapons effective to ranges out to 550 meters, a medium-weight thermal sight for crew served weapons effective out to 1100 meters, and a heavy-weight thermal sight for heavy weapons effective out to 2200 meters.

[77] McGlown, Dave., Electronic and Special Developments Division: Current Projects, 1. One robotic device being developed by the Army is the Tactical Unmanned Vehicle (TUV). The TUV is an unmanned robotic system which employs a modular payload designed to perform ISR or NBC detection tasks.

[78] Van Konynenburg, Matt. The Urban Century, 9.

[79] Alberts, David, "The Future of Command and Control with Dominant Battlespace Knowledge," in Dominant Battlespace Knowledge: The Winning Edge, eds. Stuart E. Johnson and Martin C. Libicki, (Washington, D.C.: National Defense University Press, October 1995), 81.

[80] Peters, Ralph, "Our Soldiers, Their Cities," 46.

[81] "Aliens", Twentieth Century Fox, 1986.

[82] TRADOC Analysis Center Report, Task Force XXI Advanced Warfighting Experiment Integrated Report, (Fort Leavenworth, Kansas: TRADOC Analysis Center, 1997), 1. Task Force XXI was a digitization-oriented, task organized brigade level Advanced Warfighting Experiment (AWE) conducted at the National Training Center during Rotation 96-07. The test hypothesis statement for the experiment was: "If information age battle command capabilities and connectivity exist across all battlefield operating system (BOS) functions, then increases in lethality, survivability, and tempo will be achieved."

[83] The phrase "common relevant picture" is synonymous with the existence of a state within an organization in which a high degree of situational understanding is possessed by all subordinate elements and staffs; one which reflects a consistent and identical understanding of the situation as it exists within the battle space.

[84] Task Force XXI Warfighters Digital Information Resource Guide, (Fort Monmouth, New Jersey: Communications-Electronics Command, November 1996), I-1. During Task Force XXI, at the battalion and brigade levels, Army Battle Command System (ABCS) support was provided by an integrated system of systems supporting each of the battlefield functional areas: Maneuver Control System (MCS), Combat Service Support Command and Control System (CCSCS), Advanced Field Artillery Tactical Data System (AFATDS),

Forward Area Air Defense Command and Control Intelligence (FAADC2I), and the All Source Analysis System (ASAS). Appliqué and Dismounted System Soldier (DSS) provided ABCS support at lower echelons for C2 and situational understanding. Appliqué has interfaces into the ABCS at tactical operations centers within the brigade. Soldiers interfaced through their individual DSS equipment, which were issued down to squad leader level.

[85] Dunnigan, James F., Digital Soldiers, 27..

[86] Ibid., 36.

[87] Ibid., 41.

[88] Priorities for development of technologies for the Infantry branch are set by the Commandant of the Infantry School. The priorities reflected in Table 1 are based on the Commandant's 1998 "State of the Infantry" briefing, which was presented during the 1998 Infantry Conference in June 1998 at Fort Benning.

[89] Sayre, Richard, Task Force XXI Subject Matter Experts Smart Book, (Advanced Concepts Test and Integration Directorate, Test and Experimentation Command, Fort Hood, Texas: Test and Experimentation Command, September 1996).

[90] These observations are documented in an after action report that was submitted by this author at the conclusion of a force-on-force training session conducted in preparation for the TF XXI AWE. A copy of the full report is maintained by this author.

[91] Serino, Robert, Product Manager-Land Warrior Overview, (United States Army Soldier Systems Command, Natick, Massachusetts: United States Army Soldier Systems Command Home Page), Online (http://www-sscom.army.mil/prodprog/lw/index.htm 16 January 1999), 1.

[92] Ernst, Carl F., "State of the Infantry Address." at 1998 Infantry Conference, (Fort Benning, Georgia: United States Army Infantry School, June 1998).

[93] Ibid.

[94] Ibid.

[95] Fletcher, Robert E., Small Arms Division: Current Projects, (Directorate of Combat Developments, United States Army Infantry School, Fort Benning, Georgia: United States Army Infantry Center Home Page), Online (http://www-benning.army.mil/dcd/sad.htm/ 10 April 1999.) 1.

[96] Stark, Tyrone, Clothing and Individual Equipment Division: Current Projects, (Directorate of Combat Developments, United States Army Infantry School, Fort

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[97] Litavec, Doug, Fire Power Division: Current Projects, (Directorate of Combat Developments, United States Army Infantry School, Fort Benning, Georgia: United States Army Infantry Center Home Page), Online (http://www-benning.army.mil/dcd/fd.htm/ 10 April 1999.) 1.

[98] Cummings, Tim, Mounted Systems Division: Current Projects, (Directorate of Combat Developments, United States Army Infantry School, Fort Benning, Georgia: United States Army Infantry Center Home Page), Online (http://www-benning.army.mil/dcd/msd.htm/ 10 April 1999.) 1.

[99] McGlown, Dave, Electronic and Special Developments Division: Current Projects, 1.

[100] Ibid.

[101] Sayre, Richard, Task Force XXI Subject Matter Experts Smart Book, (September 1996.)

[102] Peters, Ralph, Our Soldiers, Their Cities, 43.

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